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Copy No. *2 of a - l*

25X1

25X1

March 1, 1971

To: John C.
From: [REDACTED]
Subject: Technical Progress Report No. 10
Contract No. [REDACTED]
Reference: [REDACTED] TPR-2201201-10

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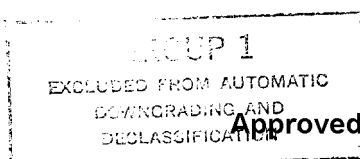
This is the tenth monthly technical progress report on [REDACTED] covering the program effort from 21 January to 20 February.

During the past month work on this program has included measurements of the OIM system frequency response, demonstration of OIM with operational material, and initiation of coherent image processing methods by fabrication of the phase component of complex in-line filters. Also several techniques for dual processing have been analyzed.

Concerning the OIM system characterization, sinusoid targets were procured and imaged through the system. Microdensitometer traces have been taken, and the data reduced for presentation. Long line targets are also being used, as well as an edge target with edge trace analysis for the frequency response measure. This measure should be completed within several weeks.

Attention has been given to demonstrating the general improvement of operational imagery when viewed through the image manipulation system. Improvements on a general class of imagery

Declassification Review by NGA/DoD



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were obtained and recorded photographically. Favorable companions were then made with unmanipulated imagery photographed through the system and with the input duplicate positives. Comparisons are now being made with prints made directly from the original negatives. It should be reiterated, however, that the image manipulation was performed on duplicate positives.

Image manipulation work at [] during the period has included the investigation of a parallel processing system which for some applications allows greater flexibility. This system, using two duplicate positives, consists of two coherent optical systems side by side with the output images superimposed through the use of a beam splitter and a mirror. Experiments have demonstrated that the registration problem imposed by the double system can be overcome. With this system dual processing can be performed by using different filters in each of the systems. For example if a matched filter is used in the first system and no filter in the second system the correlation functions are superimposed upon the object distributions. A parallel system of this sort might also be used for the processing of color separation negatives allowing the observation of the "total" reconstructed image. The system can also be used with an amplitude transparency in the first and a bleached phase transparency in the second system.

Work has also been done with in-line complex filters for the restoration of defocused imagery. The filters produced at [] are for use on a microscope. Results presently show a factor of two increase in resolution. The filters to be produced at the customers facility are for a larger scale optical system. At the present time sensitometry is being performed to control the phase image on high resolution plates, and techniques for their fabrication at the facility are being refined.

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During the coming month we will, at the customer facility, be emphasizing implementation of coherent in-line processing, and concluding the OIM characterization effort. Effort at [] is continuing to evaluate OIM techniques and their implementation at the customer facility on a microscope scale.

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Jan 20, 1969

Subject

Question

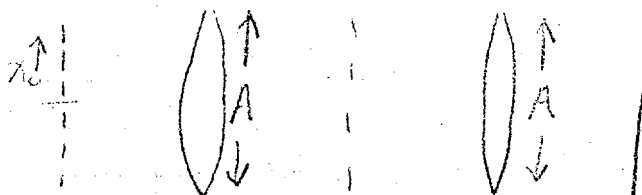
Define limits where an input-invariant impulse response exists in the optical image manipulation system —

Ref Herman, S. The Effect of Vignetting on the Impulse Response of Coherent Optical Processors, Proc IEEE, p 346, March 1969.

... from geometric arguments it can be shown that the impulse response is input-position invariant if

$$x_0 \leq \frac{A}{2} - B$$

B = bandwidth
A = diameter of lens



consider a lens, $F = 10''$
 $f/5.6$

$$\therefore A = 1.785''$$

$$A/2 = 0.893''$$

For B = width of diffraction for res. desired.
Consider 150 μ m,

$$d = \lambda F \omega$$

$$= (0.5 \times 10^{-3}) (10 \times 25.4) (150)$$

$$= (0.75) (25.4) \text{ mm.}$$

$$= 19.1 \text{ mm} = 0.75 \text{ in.}$$

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$$\begin{aligned} T_0 &\leq N_2 - 8 \\ T_0 &\leq 0.893 - 0.75'' \\ &\leq 0.143'' \end{aligned}$$

$$\leq 3.64 \text{ mm.}$$

dia. of object area = 7.2 mm

For input invariance due to vignetting.

This gives a space bandwidth product

$$@ 150 \text{ mm} \quad A = \pi r^2 = 41.55 \text{ mm}^2$$

$$SA^2 = (150)^2 (41.55) = 93.5 \times 10^4 \text{ bits}$$

THIS IS NOT THE OPTIMUM OPTICAL
QUANTITY BUT IS THAT OBTAINED
WITH PRESENT COMPONENTS.

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Lab Method

1. Focus :- To set up system and lock in.
2. Expt. Series :- to determine exposure
3. Series for data collection.

System

Input

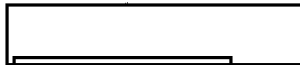
Optics & filter

Output recording film → Sensitometric measured.

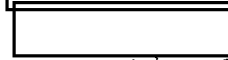
→ Microd. measured

→ Constant

Input



Long Line Target



Sinusoidal target.

01, 3, 6, 9, 12, 15, 18, 21, 24, 30, 36, 42 mm

⑥ best focus, $\pm 10 \mu$.

(I)

Long Line Target, etc.

(II)

Sinusoidal Target

The data that we collect will include that illustrated here.

I For three
Long Line
Targets —
contrast 1.1
1.3
2.0

II For a Rodak
Sinusoidal
Target contrast 2.

Modulation

Focus Focus Focus

① ② ③

Frequency

18 exposures
with and without
filter for three
contrast.

Modulation

Focus Focus Focus

① ② ③

Frequency

1
3
6
9
12
15
18
21
24
30
36
42
mm

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Subject

Polaroid copy
1/4 sec. exp for ASA 3000 @ 3.5 mag.

with filter

1, 1/2, 1/4, 1/8, 1/15, 1/30, 1/60 sec

cc - best exp

without filter

1/6, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500 sec

Sample Polaroid photos

With filter
1/4 sec. exp

Without filter
1/60 sec exp

Photo
here

Photo
here

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Jan 26, 1971

25X1

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Long line resolution test target

~~(A) Contrast 2, Medium~~
~~Focus 1 @ 26.465 cm~~

Focus 26.465 cm

	Sitter notitie		Litter notitie		Fitter notitie	
Focus	med. contrast		high contrast		low contrast	
40.7 +20µ	1	1/4'	6	1/60'	15	1/4'
40.5 0µ	2	5	9	12	16	19
33 -20µ	3	4	10	11	17	18
	3(a)					

blank #7 4 #14

@ Photos of output prior to above exp
 focus 26.465 cm.
 with Sitter without Sitter

Photo
here

Photo
here

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25X1

Subject

Instructor's Name

Sinusoidal target 30% modulation

Roll B

11mm

3mm

6mm

20 filter no filter

filter no filter

filter no filter

407m 200 1 1/4 6 100

12 1/4 13 100

15 1/4 20 100

405 " 0 2 " 5 "

9 " 12 "

16 " 19 "

403 " 200 3 4 4 "

10 " 11 "

17 " 18 "

7 blank

14 blank

Roll C

9mm

12mm

15mm

fil Nfil

fil Nfil

fil no fil

407m 200 1 1/4 6 100

12 1/4 13 100

15 1/4 20 100

405 " 0 2 " 5 "

9 " 12 "

16 " 19 "

403 " 200 3 4 4 "

10 " 11 "

17 " 18 "

Roll D

18mm

21mm

26mm

Panel

Roll E

30

36

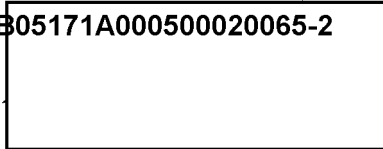
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Panel

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Subject



Revised copies of processed + unprocessed output
@ 30 + 45 mm.

30 mm no filter 1/30 sec.

with filter, 1/4 sec

Photo here

photo
here

30 mm no filter, 1/30 sec.

with filter, 1/4 sec.

Photo
here

Photo
here

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Jan 28, 1971

Date

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Repeat Roll A because we notice that the low contrast target goes out of focus at about 52 ℓ /mm. There were reference marks scratched into emulsion that caused curls of emulsion to go upward from the surface. These could cause a defocus ... and were removed for this new series.

Roll F (same as Roll A) Long Line Target
 26.387 on Med ant. High C Low C
 26.385 " with tilt/rot $\pm 1/16$ $\pm 1/16$
 26.383 "
 Same as before, 18 ℓ /p.

With Dennis R. concerning target data

27

-0.5 mils

Best focus at 0.0 mils.

-1.0

Determine amt of defocus.

-2.0

-3.0

Plan an experiment for OIM with in-line complex filters.

+1.0

+2.0

28

+2.9 mils

1.0 best

-1.7

-2.8

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Feb 23, 25X1
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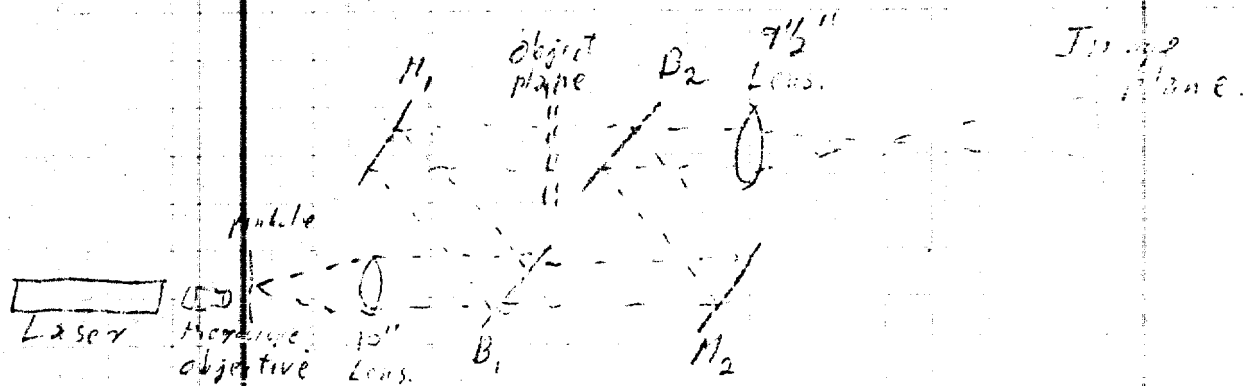
Instructor's Name

These two days notes are selections of imagery for operational processing, and are stored at customer facility in John's program file.

Feb 8, 1971 25X1

[Redacted Box]

A.M. Set up of a Mach-Zehnder interferometer for measuring phase plates. The following were set up on the granite slab.



The frequency of the fringes are set so that there are about eight lines across the format of the object of interest.

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Date Feb 1, 77 210

Subject

Instructor's Name

John and I concluded the set up of the Mach-Zehnder in the A.M.

Note: The finger should be oriented so that they go $\perp$ to the sample.

eg.  sample.
Finger's.

P.M.

Work on sensitometry of H.R.P. for making phase plates.

Procedure.

Light source - Muller printer

Exposure - Through a Kodak step wedge onto a HRP (contact print)

- Through glass onto a test plate for checking constant exposure.

Development - Developing plate in D-76 and

Follow instructions delivered.

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Subject _____

Instructor's Name _____

All plates will be developed by Max
so consistency can be checked without
a change in agitation by a new person.

The test plate will be a 4x5 HP1P
that will be exposed with each sample
step wedge. This plate will be developed
at the end of each day or after about
eight exposures have been made on it.
Since all these exposures will be made
on the same plate and developed at the
same time ~~and~~ any change in
density will be caused by a change
in exposure. (all exposure will be
10 min.)

Four plates were processed this PM
and measured on the densitometer.
The densities did not compare as

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Subject

Instructor's Name

A.M.
Four more plates were exposed and developed.
Each time a plate was developed the temperatures
of the chemicals were checked to see that
they were at 68°F .

The test plate was also developed at
this time, no. of test exposure = 8.

All these plates were ~~developed~~ measured
on the densitometer and the results are
as follows:

Several of the plates were repeated steps
for step within .02 density units.

The test plate was saturated so
that no information was obtained
as to the constant exposure of the
Mikro light source.

The new test plate will have three
density steps on it so that a good
comparison may be made between the exposures.

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25X413

Subject

Instructor's Name

Two plates were bleached using the procedure outlined.

One of the plates was set up in the 4.5 exposure timer and photographed onto Pan X film. An exposure time of $1/15$ to $1/60$ will give me good results.

Reticulation problem.

Bleached plate by John showed that there was reticulation present. An observation showed that it was possible to get this from the grain structure of the step wedge.

John & I designed a little experiment to see if this was true and also if it was a function of density.

The test was to expose a plate only through glass with several exposures

1, 2, 4 sec. This plate would be developed, bleached and observed.

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25X1

14

Subject _____

Instructor's Name _____

The results of this plate showed that there was no deterioration present under the density images as found. Thus the deterioration was caused by grain structure on the step wedge.

Instructions for Max for Wed, Thurs, Fri.

1. Expose several plates a day and develop to see if a constant process can be obtained.
2. Use a test plate to see if the exposure times are constant.
3. Be very critical of the temperature control.

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Date Feb 16, 1971 15X1

Subject

Instructor's Name

Round plate

Plate # 10.3
Top 6
 9 1.63
 10 1.74
 11 1.56
 12 1.60
 13 1.64
 14 1.76
 15 1.56
 16 1.56

Mid 6
 1.37
 1.57
 1.56
 1.58
 1.58
 1.56
 1.60
 1.60

ΔD of 6 plates = .2
 ΔD of 7.5 plates = .18
 ΔD of 8 plates = .28
 ΔD of 53 plates = .07

Test plate $\Delta D = .03$

$\Delta D = .03$

Voltage or exposure change.

17 1.74 2.00

12th Feb 18 1.64 1.86

19 1.58 1.81

20 1.62 1.79

$\Delta D = .16$

Test plate $\Delta D =$

$\Delta D = .06$

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Student's Name

Date

25K6

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Subject

Instructor's Name

Monitor of line voltage

Time	No load	load
10 AM	118.0	117.4
11 AM	117.3 *	116.6
2 PM	118.0	117.4

* Note: The line voltage dropped by about one volt when the chemists switched on their heater. Each time the heater goes on and off the voltage changes by .7 volts

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Date

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Subject

Instructor's Name

Black mirror

Plates #14 and #17

All chemicals were checked for 62°F

Dev + D worked together on this for both times and temperature.

Development of the Mach-Zehnder interferometer
The Mach-Zehnder was realigned for
better format so that all steps could
be photographed at once.

Plates 14 + 17 were set up in the interferometer
and exposed on Pan X film.

Development of Pan X

Developer HC-110 Stock 1 part to 3 parts H₂O

Time 3 min inter agitation

Exposure times were 1/4, 1/8, 1/10 sec.

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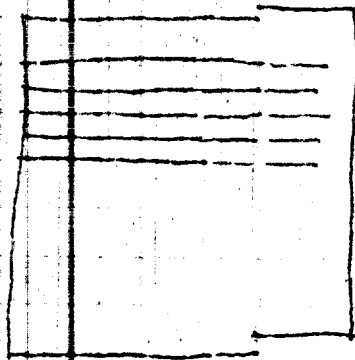
Instructor's Name

into first finger some made me move
on pages 209 + 210.

Method of measurement

1. Cut the print along the edge that shows a shift.
2. align the fringe of the first step and measure the displacement of the print at the top or bottom.

B1



$\frac{1}{4}$ fringe shift

3. Measure the distance of a complete fringe shift

a) align the top + bottom of print sheet

b) Place a ruler on one fringe

c) move the sheet up to next fringe

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Subject _____

Instructor's Name _____

d. measure the sheet shift at the bottom of the sheet.

4. Using step 2 measure the remaining steps.

Density measurement	Phase shift
2.58	00.5%
2.468	63.6
2.28	54
2.08	43.4
1.76	30
1.57	30.3
1.22	20
1.08	15
.65	15

See page 22 for graph of density vs phase.

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25X1
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Subject

Interferogram of plate #14

Instructor's Name

[Empty box for Instructor's Name]

*Interferogram
Print*

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25X1
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Subject

Interferogram of plate #16

Instructor's Name

*Interferogram of
plate #16*

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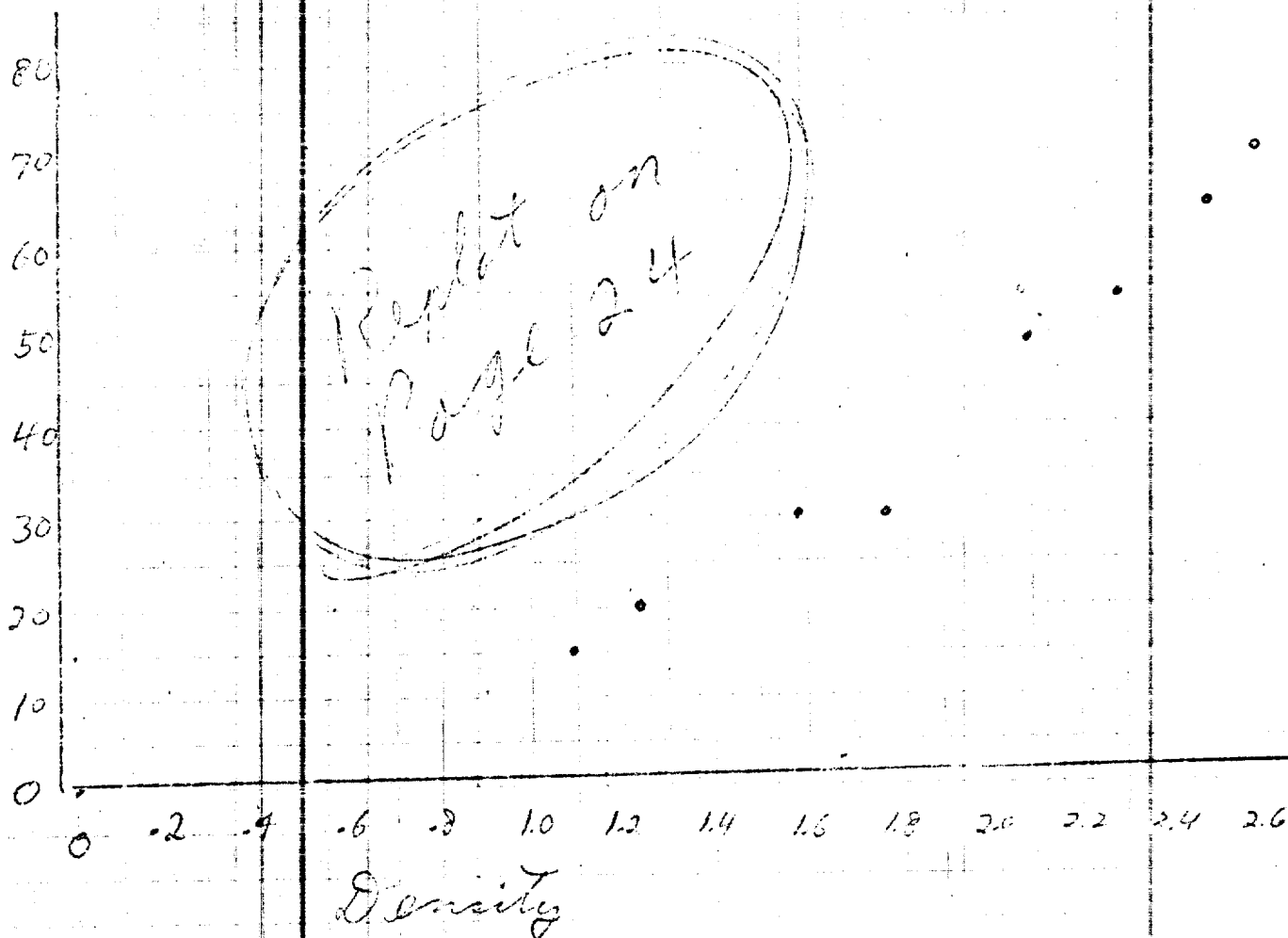
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This curve is for only one sample and therefore should not be taken as the exact relationship of phase vs density.

For a 50% shift using 5461 Å we need

$$\frac{6328}{5461} \times 50\% = 50\%$$

$$\text{or } \% = \frac{50 \times 5461}{6328} = 43.2\%$$

when using 6328 Å (laser light from the interferometer).

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Subject

Instructor's Name

Bleach process

Plates # 18420 bleached this AM.

Plate #18

Step	Density	Shift
1	2.14	65
2	1.64	60
3	1.14	40
4	.63	13.3

Plate #17

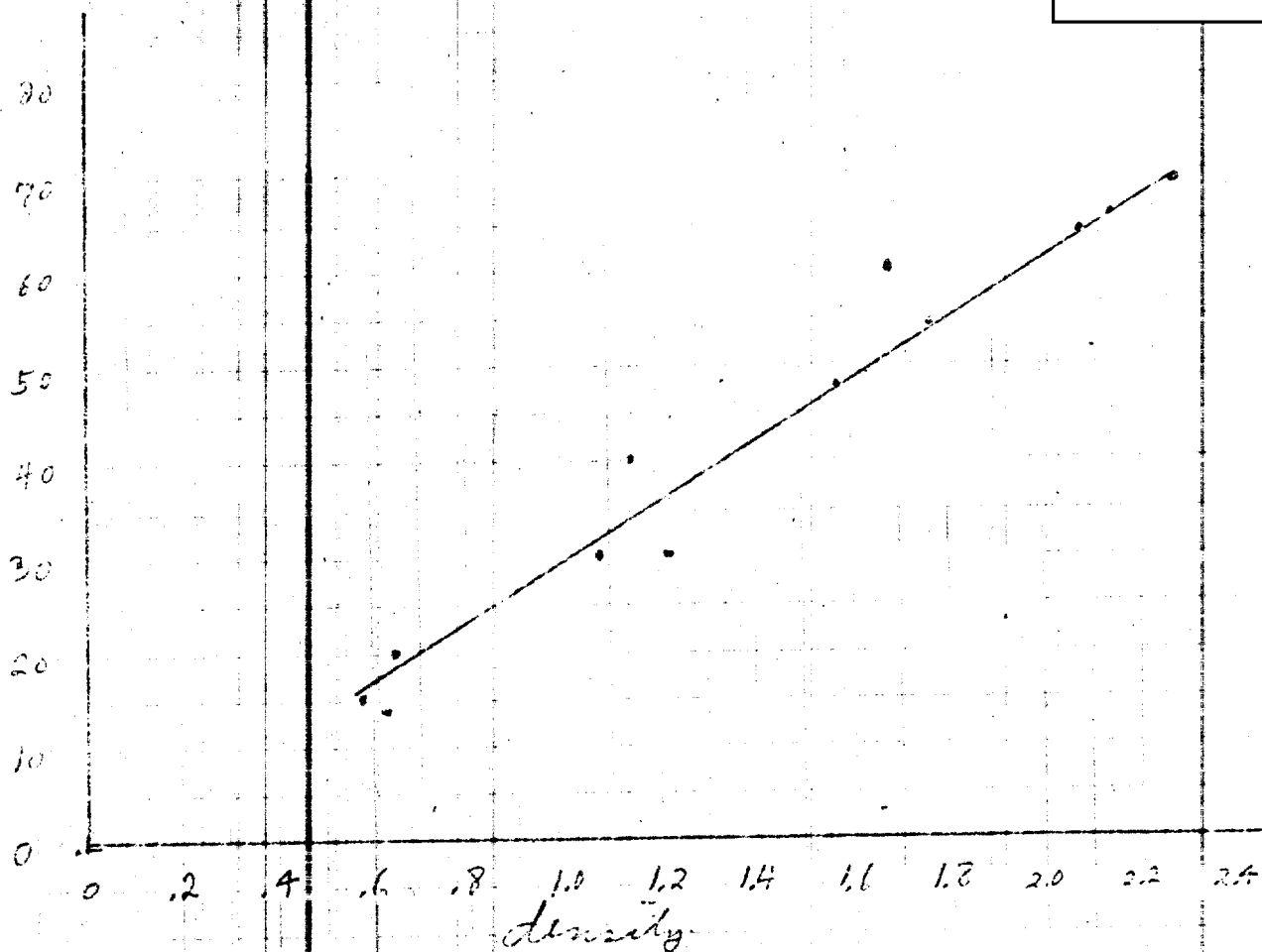
1	2.13	56
2	1.62	47
3	1.10	31
4	.60	12.5

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Subject

Instructor's Name



Plot of plates # 14-17-18, phase vs. density

This curve indicates that a density of about 1.6 is needed for a phase shift of 50% for a 320 Å light source, and 1.42 a density of 1.42 for a 5.46 Å light source.

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Subject

Instructor's Name

Work to be done by Max for the next two weeks:

1. Use one full day to expose and develop slip wipers on 4x5 H.R.P. a test plate. Should also be made to check exposure variations.

2. Record the above densities and compare with plates that have been previously made.

3. Blacken half of the above plates and

a. Make interferograms

b. Make 8x10 prints of the interferograms

c. Measure and record the phase shift

d. Make comparisons of the new phase shift and the one previously made.

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